Using LiDAR and RapidEye to provide enhanced area and yield descriptions for New Zealand small-scale plantations

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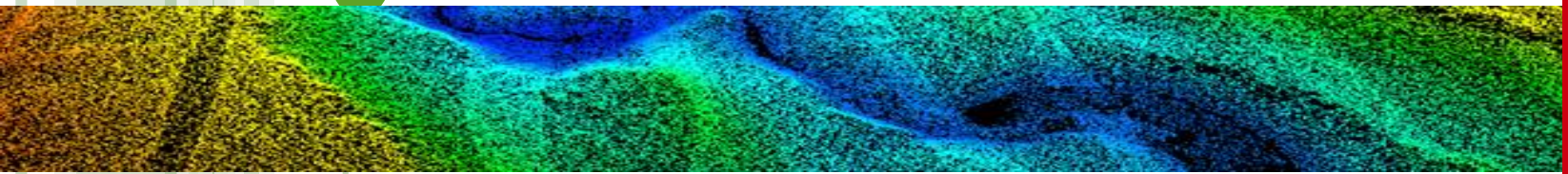

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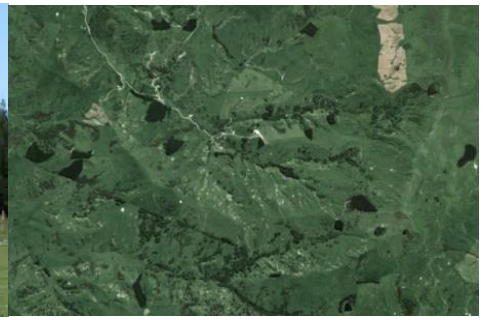
Background and Introduction

- Small-scale plantation forests (30% of all plantations) are not well understood in net stocked area
- Small-scale forests lacks yield information
- NZ lacks accurate spatial representation of small-scale plantations
- Increasing availability of cost-effective remote sensing data





Research objectives

- Evaluate different combinations of remote sensing techniques and datasets in mapping net stocked plantation forests

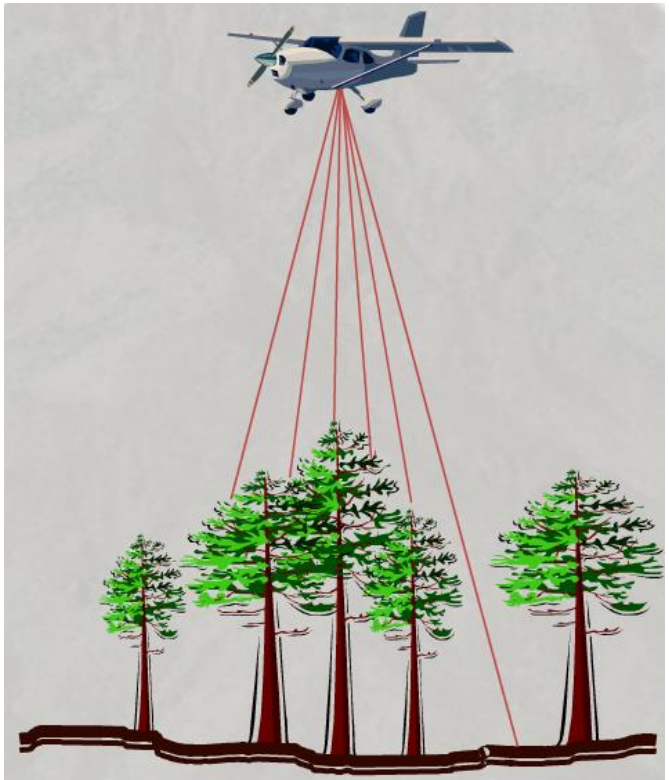
- Evaluate different modelling approaches and remote sensing datasets in modelling height, basal area, volume and stand age

- Apply the selected area mapping and modelling approaches to the Wairarapa region

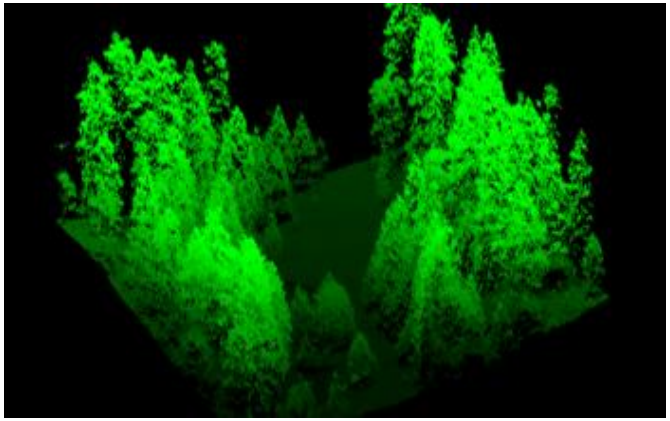
LiDAR

- Light Detection And Ranging
- Active sensor fires laser pulse
- Time of flight determines distance from target
- If position of sensor is known, position of target can be calculated

- Applications in Forestry
  - DTM
  - Height, volume, biomass
  - Wood quality and grade outturn

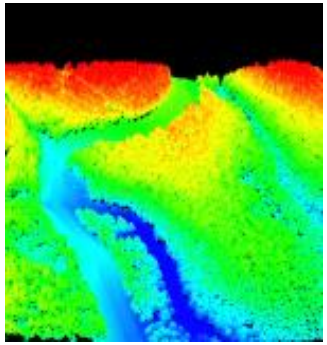


The lidar system maps out the earth's surface by recording the reflection information of the laser pulses. Source: US Forest Service



Remote Sensing Datasets

Dataset	Resolution	Temporal Coverage	Description	Application
Aerial Photography	0.3 m	Dec 2012-Jan 2013	Orthorectified aerial photography: RGB	Ground truthing for forest mapping
Airborne LiDAR	3.7 points per m^2	Jan-Dec 2013	Wall-to-wall for Wellington Region	Derived surfaces for forest mapping, metrics for model stand variables
RapidEye	5 m	Nov 2013-Feb 2014	5-band multispectral imagery: RGB, RE, NIR	Derived surfaces for forest mapping, metrics for model stand variables

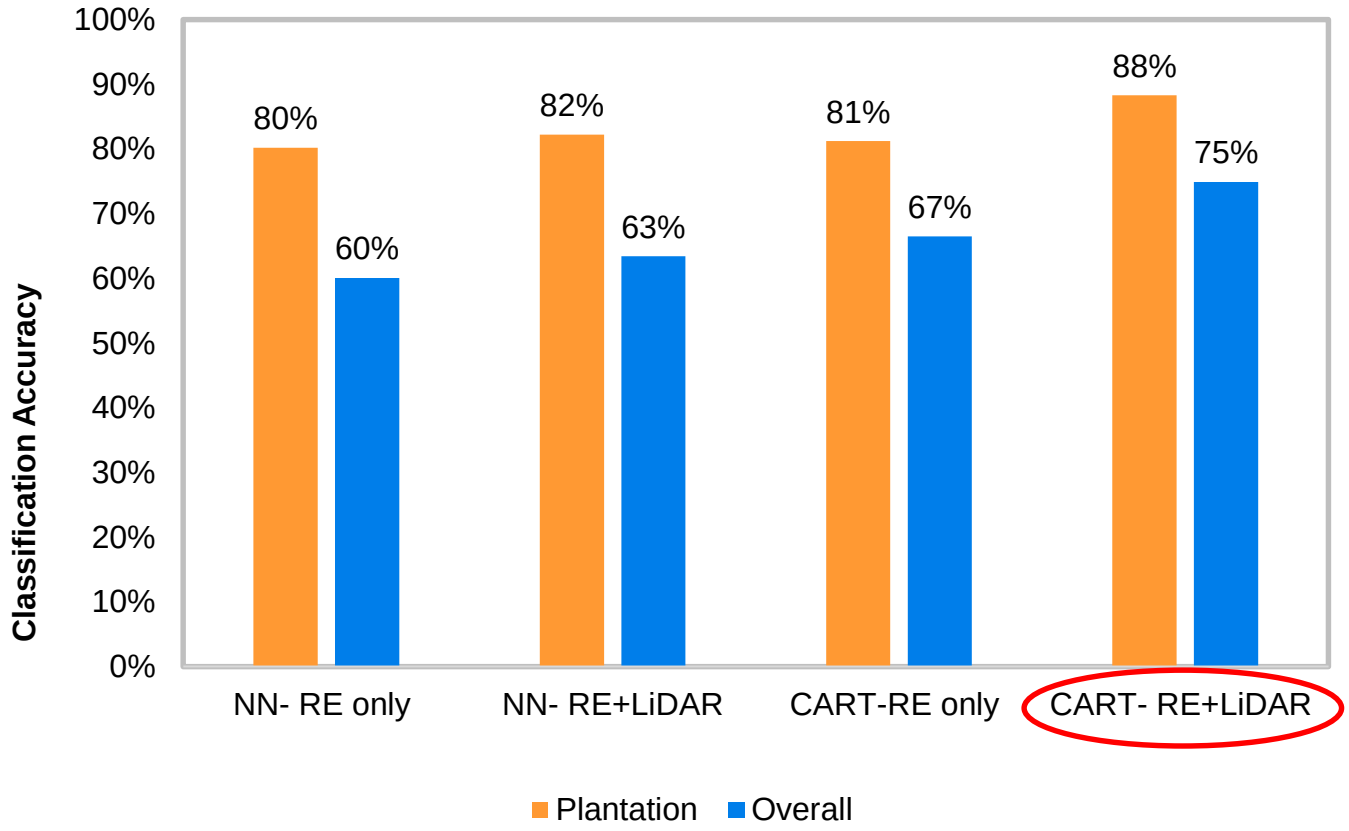


Methodology

- Area
  - OBIA classification approaches NN and CART with RapidEye and RapidEye + LiDAR surfaces
  - Evaluate performance using classification accuracy and comparison with manual digitised areas
- Yield
  - Model forest age, MTH, BA and VOL using MLR, SUR, k-NN and RF with LiDAR, RapidEye and LiDAR + RapidEye attributes
  - Evaluate model performance by comparing RMSE

Forest Mapping – Results

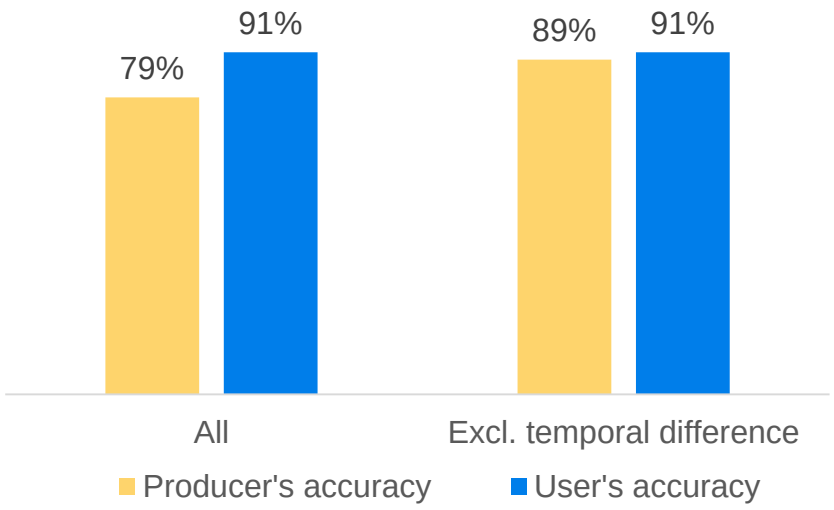
Classification accuracy of different mapping approaches and datasets

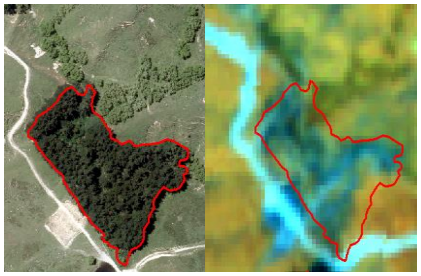


NN: Nearest Neighbour
CART: Classification and Regression Tree

Mapping results for plantation

All Validation Grids



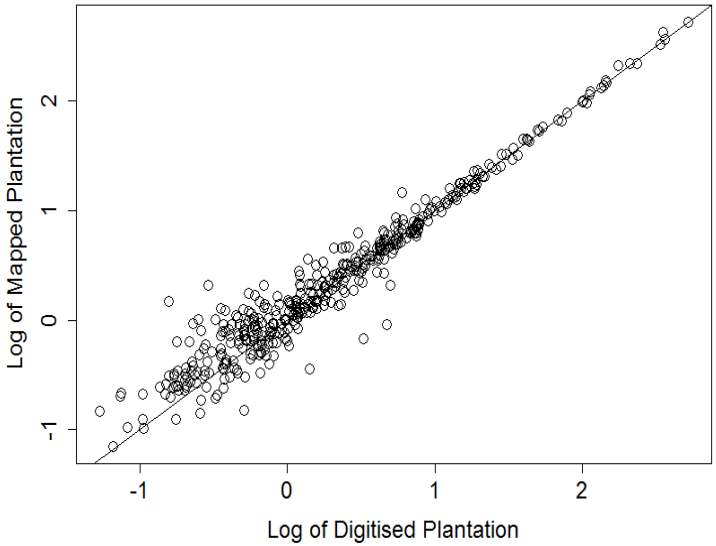


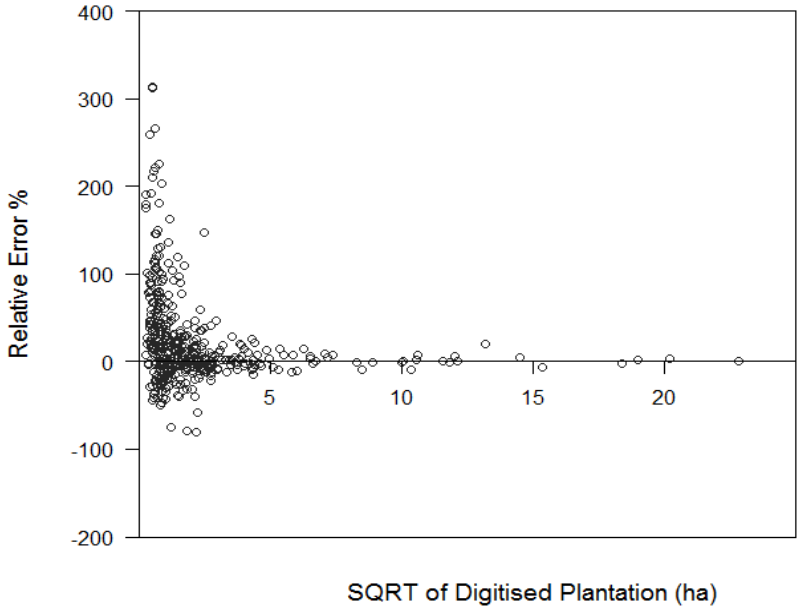
	Total Digitised (ha)	Total Mapped (ha)	Difference (ha)	Difference %	MAE (ha)	RMSE (ha)
All standing trees	6244. 4	5759. 2	-485.2	-7.8%	13.6	42.5
Exclude new plantings	5590. 8	5759. 2	168. 5	3.0%	5.7	9.6

Note: New plantings are generally not visible on satellite imagery

Forest Mapping

- Patch-level comparison

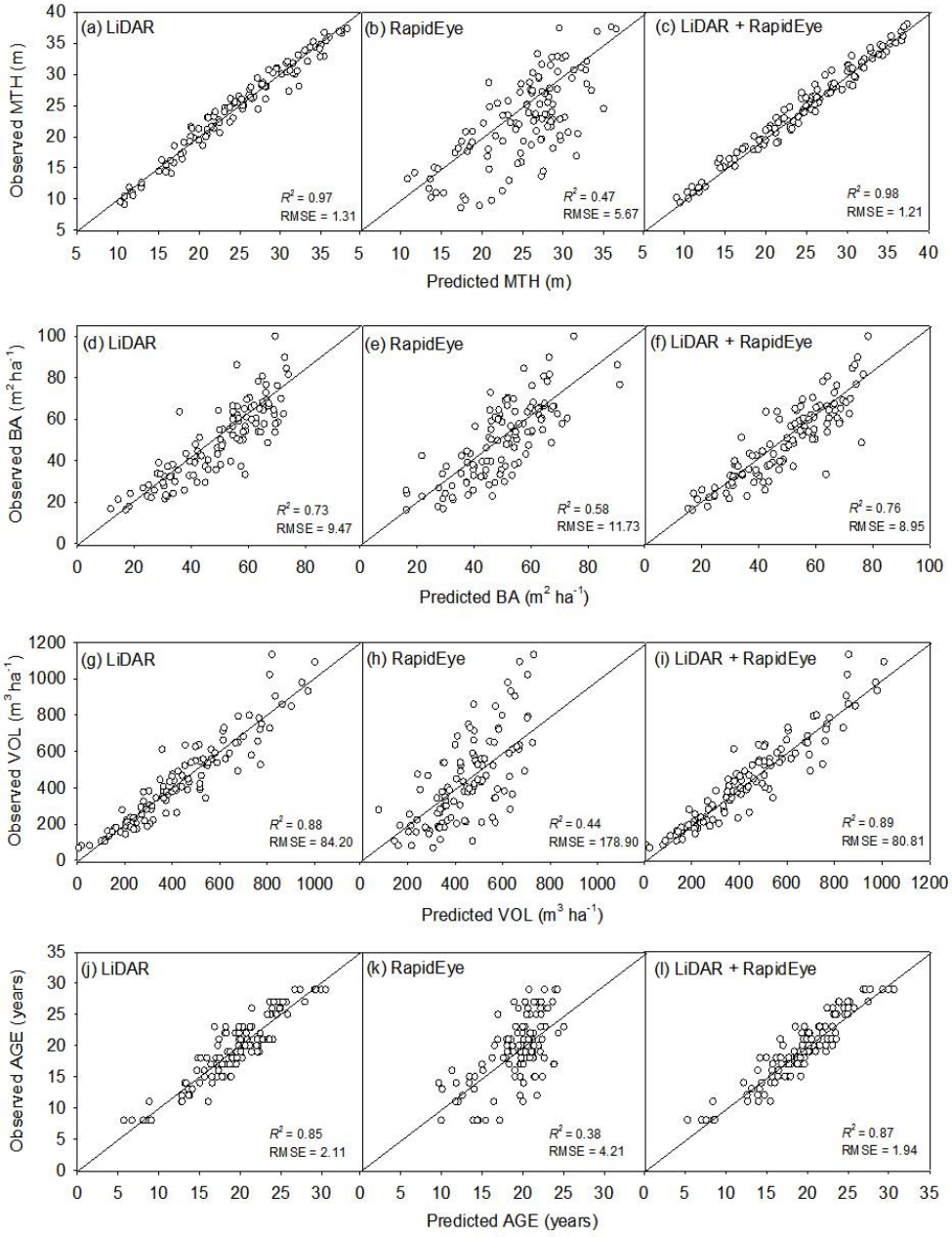




423 sets of valid patch to patch comparisons
All patched: Average patch size: 9.5 ha, mean absolute error = 0.8 ha
Large areas are more accurately mapped

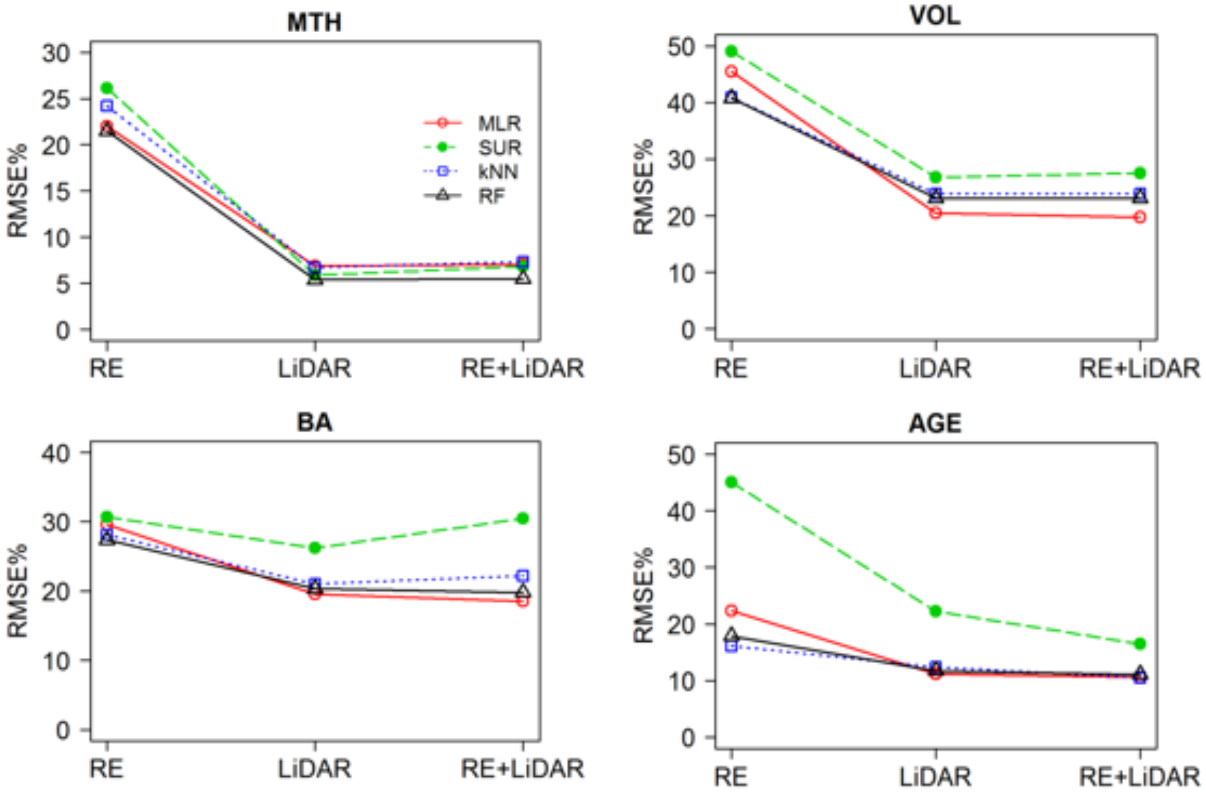
Modelling stand Variables – results

MLR model



Modelling stand variables

Model comparison based on 10-fold cross-validation



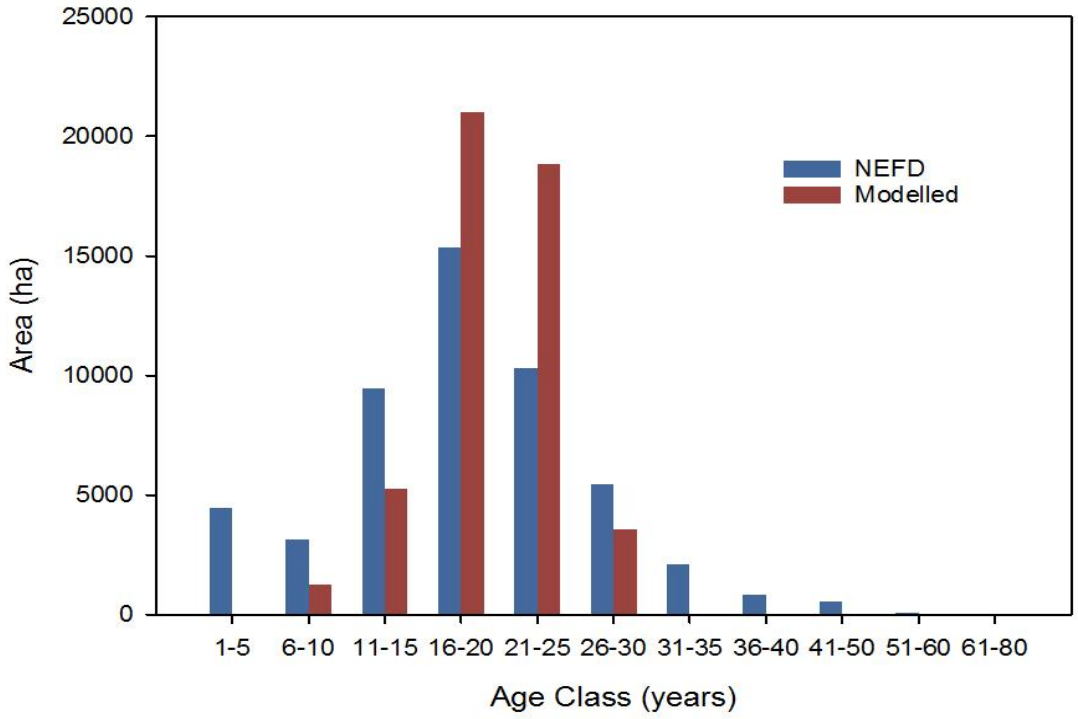
Comparison of Root Mean Square Error as a percentage of predicted mean (RMSE%) for MTH, BA, VOL and age estimated by MLR, SUR, k-NN and RF models.

- MLR models with LiDAR attributes marginally outperformed other approaches in estimating age, MTH, BA and VOL.

Application to Wairarapa

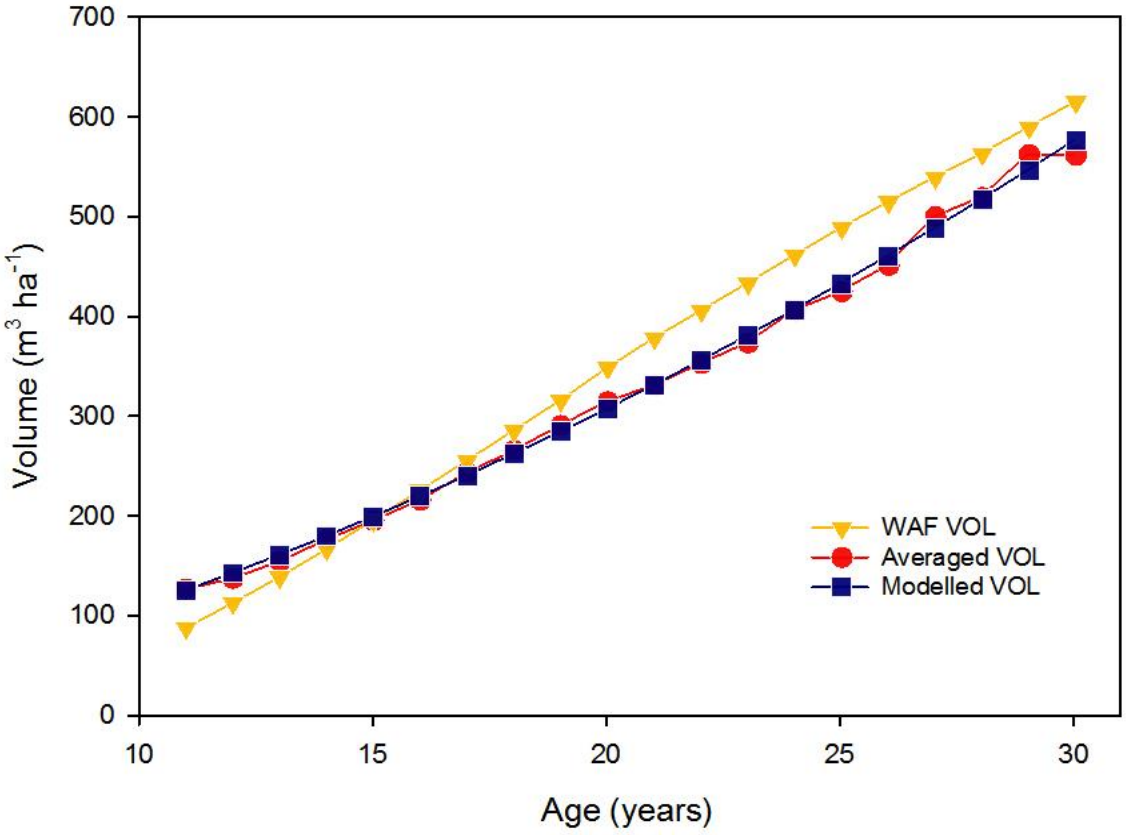
Plantation Area

	Mapped plantation (ha)	Digitised young plantation (ha)	Total plantation (ha)	NEFD plantation (ha)	LCDB plantation (ha)
Total	**47 168**	**2 956**	**50 124**	**51 871**	**56 038**



Application to Wairarapa

- Yield comparison



Implication

- Improve understanding of small-scale forests
  - Identify where they are
  - What the productive areas are
  - How much wood is there
- Application to all regions in NZ
  - Develop a national geospatial database of plantation
  - Estimate stand variables to the plantations
  - Allow future update and monitoring of the resources

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- Land Information New Zealand

Thank You